Metropolitan Water Reclamation District of Greater Chicago

RESEARCH AND DEVELOPMENT DEPARTMENT

REPORT NO. 06-45

GROUNDWATER MONITORING REPORT

TUNNEL AND RESERVOIR PLAN
MAINSTREAM TUNNEL SYSTEM
2005 ANNUAL REPORT

AUGUST 2006

Protecting Our Water Environment

Metropolitan Water Reclamation District of Greater Chicago

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Louis Kollias, P.E., BCEE
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August 8, 2006

Ms. Marcia Willhite, Chief
Bureau of Water
Illinois Environmental Protection Agency
P. O. Box 19276
Springfield, IL 62794–9276

Subject: Mainstream TARP System Groundwater Monitoring Annual Report for the Year 2005

Dear Ms. Willhite:

Enclosed are three copies of "Groundwater Monitoring Report, Tunnel and Reservoir Plan Mainstream Tunnel System 2005 Annual Report."

Very truly yours,

Louis Kollias
Director
Research and Development

LK:JSJ:lmf
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GROUNDWATER MONITORING REPORT

TUNNEL AND RESERVOIR PLAN
MAINSTREAM TUNNEL SYSTEM
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Research and Development Department
Louis Kollias, Director

August 2006

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MAINSTREAM TUNNEL SYSTEM
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Introduction

This report contains 2005 data for the TARP Mainstream Tunnel System compiled from monitoring of groundwater elevations in observation wells, and monitoring of groundwater quality in water quality monitoring wells. The observation wells are all sampled once every two months while the monitoring wells are sampled at varying frequency. Monitoring wells QM–53, QM–56, QM–58, QM–61, QM–68 through QM–74, QM–76, QM–77, and QM–81 are sampled three times per year (Illinois Environmental Protection Agency [IEPA] memorandum July 9, 2004). Monitoring wells QM–62 through QM–65, QM–67, QM–75, QM–78 through QM–80, and QM–82 are sampled six times per year (IEPA memorandum July 9, 2004). Sampling of water quality wells QM–51, QM–52, QM–54, QM–55, QM–57, QM–60, and QM–66 was discontinued with the approval of the IEPA (memorandum dated May 4, 1994). Water quality monitoring well QM–59 has been dry since February 1995 and is no longer being monitored. The observation wells and water quality monitoring wells are located along the length of the Mainstream Tunnel between Morton Grove and Hodgkins.

Monitoring Data

Appendix AI contains a location map of observation wells OM–1 through OM–23 located along the Mainstream Tunnel System.

Table AII–1 in Appendix AII contains groundwater elevation data for the year 2005 for observation wells OM–1 through OM–23 located along the Mainstream Tunnel System. Table AII–1 also contains the yearly minimum, mean, and maximum water level elevations of each observation well.

Appendix AIII contains a location map of water quality monitoring wells QM–53 through QM–82 located along the Mainstream Tunnel System.

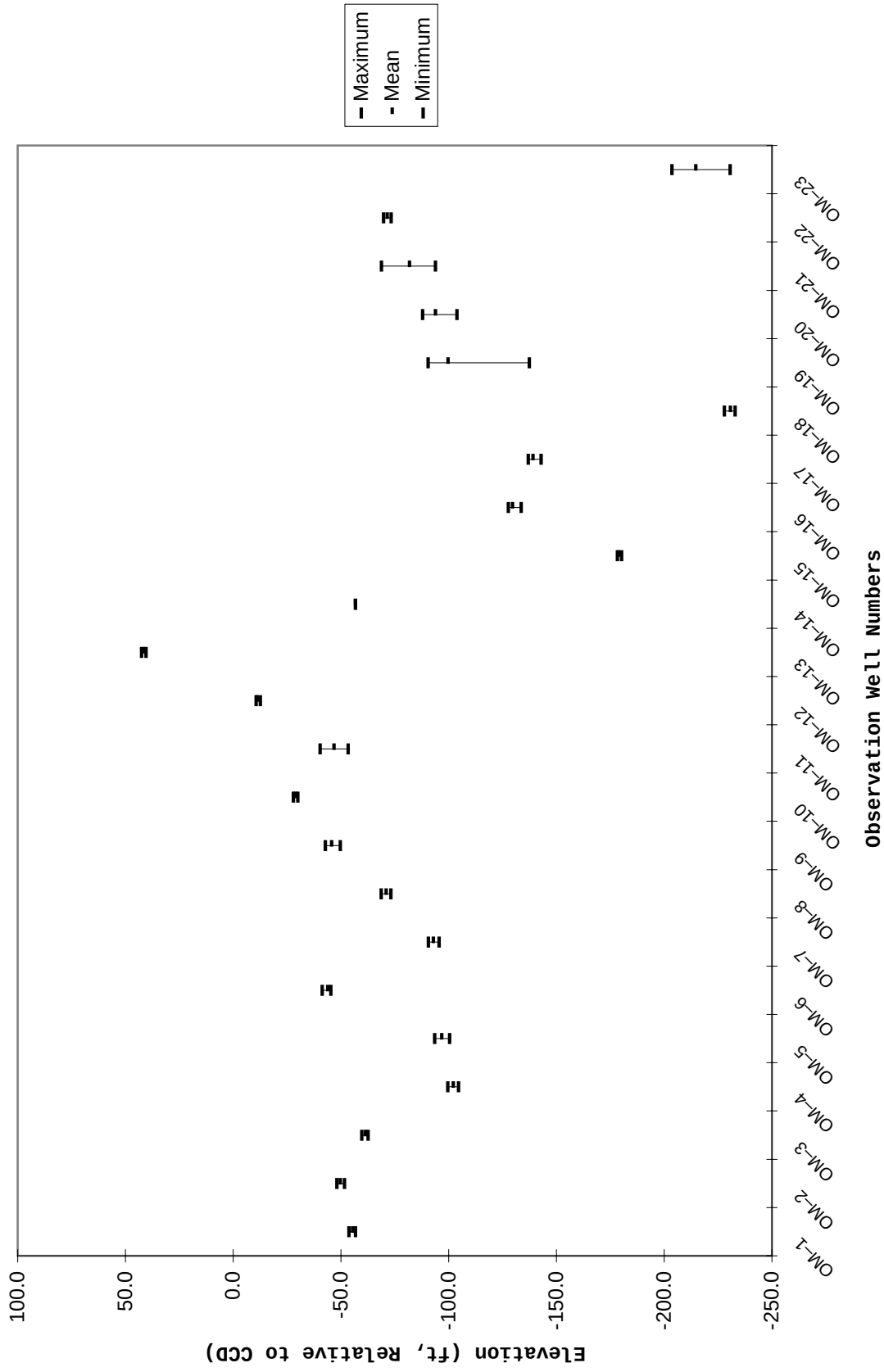
Tables AIV–1 and AIV–2 of Appendix AIV contain water quality data for the year 2005 pertaining to water quality monitoring wells QM–53 through QM–82 located along the Mainstream Tunnel System.

All of the wells in the Mainstream system were visited for the required number of samples. However, in some instances the samples could not be collected. Water quality well QM–62 could not be sampled on January 5, 2005, May 25, 2005, July 27, 2005, September 8, 2005, October 18, 2005, or November 8, 2005, because the pump could not be activated because of a structural problem with the well. The District is currently reviewing options regarding the disposition of the well. Water quality well QM–68 could not be sampled in January 13, 2005, because snow was blocking access to the well. Water quality well QM–73 could not be sampled on April 7, 2005, because the pump was inoperable.

Summary of Data

Observation Wells Water Level Elevation Data. In Figure 1, the 2005 groundwater level elevation data for the observation wells (OM–1 through OM–23) of the Mainstream Tunnel System have been plotted. In this figure, minimum, mean, and maximum water level elevations of all the observation wells are plotted to show fluctuations in water

Figure 1: 2005 MINIMUM, MEAN, AND MAXIMUM WATER LEVEL ELEVATIONS FOR THE MAINSTREAM TUNNEL SYSTEM OBSERVATION WELLS



level elevations during 2005. Table AII–1 in Appendix AII contains the groundwater level elevation data for the year 2005 for the observation wells located in the Mainstream Tunnel System.

Water Quality Monitoring Wells Data. Tables 1 through 5 contain summary statistics of the water quality parameters for the year 2005 for water quality monitoring wells QM–53 through QM–82 in the Mainstream Tunnel System. These statistics are computed from the 2005 data collected from each water quality well. The summary statistics include minimum, mean, maximum, standard deviation (Std. Dev.), median and coefficient of variation (Coeff. Var.) for all nine water quality parameters analyzed during 2005. The nine water quality parameters are: chloride (Cl), conductivity (Cond.), fecal coliform (FC), hardness as $CaCO_3$ (Hard.), ammonia as NH_4^+–N, pH, sulfate (SO_4), total dissolved solids (TDS), and total organic carbon (TOC).

Table 1: SUMMARY STATISTICS OF THE 2005 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM–53, QM–56, QM–58, QM–61, AND QM–62

Parameter		Well Number				
		QM–53	QM–56	QM–58	QM–61	QM–62
Cl, mg/L	Minimum	14	39	16	45	—
	Mean	15	42	18	47	—
	Maximum	17	47	22	50	—
	Std. Dev.	2	4	3	3	—
	Median	15	40	16	47	—
	Coeff. of Var.	10	10	19	5	—
Cond., µmhos/cm	Minimum	240	372	526	229	—
	Mean	253	381	534	400	—
	Maximum	263	396	542	531	—
	Std. Dev.	12	13	8	155	—
	Median	257	376	534	439	—
	Coeff. of Var.	5	3	1	39	—
FC,* cfu/100 mL	Minimum	1	1	1	1	—
	Geo. Mean	1	1	1	1	—
	Maximum	1	1	1	1	—
	Geo. Std. Dev.	0	0	0	0	—
	Median	1	1	1	1	—
	Coeff. of Var.	0	0	0	0	—
Hard., as $CaCO_3$, mg/L	Minimum	122	128	265	108	—
	Mean	128	127	268	110	—
	Maximum	134	132	271	113	—
	Std. Dev.	6	6	3	3	—
	Median	129	128	268	108	—
	Coeff. of Var.	5	4	1	3	—
NH_4^+–N, mg/L	Minimum	0.08	0.47	0.96	0.24	—
	Mean	0.08	0.47	0.99	0.25	—
	Maximum	0.09	0.47	1.04	0.27	—
	Std. Dev.	0.01	0.00	0.05	0.02	—
	Median	0.08	0.47	0.96	0.25	—
	Coeff. of Var.	6.93	0.00	4.68	6.03	—

Table 1 (Continued): SUMMARY STATISTICS OF THE 2005 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM–53, QM–56, QM–58, QM–61, AND QM–62

Parameter		Well Number				
		QM–53	QM–56	QM–58	QM–61	QM–62
pH	Minimum	7.1	7.2	7.3	7.5	—
	Mean	7.6	7.7	7.5	7.7	—
	Maximum	8.2	8.0	7.8	8.0	—
	Std. Dev.	0.6	0.4	0.3	0.3	—
	Median	7.4	7.8	7.5	7.6	—
	Coeff. of Var.	7.5	5.4	3.3	3.4	—
SO_4, mg/L	Minimum	33	12	159	6	—
	Mean	34	11	166	13	—
	Maximum	34	15	171	26	—
	Std. Dev.	1	4	6	11	—
	Median	34	12	169	8	—
	Coeff. of Var.	2	36	4	83	—
TDS, mg/L	Minimum	186	277	426	296	—
	Mean	213	292	460	303	—
	Maximum	246	304	480	316	—
	Std. Dev.	30	14	30	12	—
	Median	208	296	474	296	—
	Coeff. of Var.	14	5	6	4	—
TOC, mg/L	Minimum	1	2	1	1	—
	Mean	1	2	1	1	—
	Maximum	1	2	2	1	—
	Std. Dev.	0	1	1	0	—
	Median	1	2	1	1	—
	Coeff. of Var.	0	35	43	0	—

*For purposes of statistical evaluation, fecal coliform values less than 1 were set equal to 1.

Table 2: SUMMARY STATISTICS OF THE 2005 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM–63, QM–64, QM–65, QM–67, AND QM–68

Parameter		Well Number				
		QM–63	QM–64	QM–65	QM–67	QM–68
Cl, mg/L	Minimum	51	52	362	171	55
	Mean	56	54	401	221	217
	Maximum	64	58	456	269	379
	Std. Dev.	5	3	39	39	229
	Median	53	53	385	223	217
	Coeff. of Var.	10	5	10	18	106
Cond., µmhos/cm	Minimum	317	323	761	650	241
	Mean	968	462	1512	1002	276
	Maximum	1644	619	2100	1239	310
	Std. Dev.	505	120	601	256	49
	Median	880	438	1564	1083	276
	Coeff. of Var.	52	26	40	26	18
FC,* cfu/100 mL	Minimum	1	1	1	1	1
	Geo. Mean	1	1	1	1	1
	Maximum	1	1	3	1	1
	Geo. Std. Dev.	0	0	2	0	0
	Median	1	1	1	1	1
	Coeff. of Var.	0	0	68	0	0
Hard., as $CaCO_3$, mg/L	Minimum	812	197	545	347	202
	Mean	891	207	569	384	205
	Maximum	996	225	609	424	207
	Std. Dev.	66	10	22	29	4
	Median	879	204	565	381	205
	Coeff. of Var.	7	5	4	8	2
NH_4^+–N, mg/L	Minimum	1.60	1.60	6.36	7.39	1.21
	Mean	1.83	1.85	7.44	8.39	1.26
	Maximum	2.10	1.98	9.01	9.54	1.31
	Std. Dev.	0.17	0.14	1.00	0.83	0.07
	Median	1.80	1.88	7.14	8.30	1.26
	Coeff. of Var.	9.58	7.62	13.40	9.89	5.61

Table 2 (Continued): SUMMARY STATISTICS OF THE 2005 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM–63, QM–64, QM–65, QM–67, AND QM–68

Parameter		Well Number				
		QM–63	QM–64	QM–65	QM–67	QM–68
pH	Minimum	7.2	7.2	7.1	7.0	7.1
	Mean	7.4	7.5	7.4	7.3	7.3
	Maximum	7.6	7.9	7.6	7.4	7.4
	Std. Dev.	0.2	0.2	0.2	0.2	0.2
	Median	7.4	7.5	7.4	7.4	7.3
	Coeff. of Var.	2.5	3.2	2.8	2.3	2.9
SO_4, mg/L	Minimum	796	34	182	31	34
	Mean	911	40	208	49	36
	Maximum	1008	44	218	105	38
	Std. Dev.	68	4	14	29	3
	Median	913	41	211	36	36
	Coeff. of Var.	7	9	7	59	8
TDS, mg/L	Minimum	1578	458	1360	840	328
	Mean	1716	534	1439	942	354
	Maximum	1878	594	1504	1000	380
	Std. Dev.	123	53	60	66	37
	Median	1693	535	1451	957	354
	Coeff. of Var.	7	10	4	7	10
TOC, mg/L	Minimum	2	1	6	3	1
	Mean	3	2	8	5	1
	Maximum	4	3	12	6	1
	Std. Dev.	1	1	2	1	0
	Median	3	2	8	5	1
	Coeff. of Var.	35	49	29	23	0

*For purposes of statistical evaluation, fecal coliform values less than 1 were set equal to 1.

Table 3: SUMMARY STATISTICS OF THE 2005 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM–69 THROUGH QM–73

Parameter		Well Number				
		QM–69	QM–70	QM–71	QM–72	QM–73
Cl, mg/L	Minimum	35	45	118	127	42
	Mean	35	48	123	132	44
	Maximum	36	53	130	136	45
	Std. Dev.	1	4	6	5	2
	Median	35	47	122	132	44
	Coeff. of Var.	2	9	5	3	5
Cond., µmhos/cm	Minimum	292	304	396	356	266
	Mean	332	403	501	415	332
	Maximum	402	458	640	513	398
	Std. Dev.	61	86	126	85	93
	Median	302	447	467	377	332
	Coeff. of Var.	18	21	25	21	28
FC,* cfu/100 mL	Minimum	1	1	1	1	1
	Geo. Mean	1	1	1	1	1
	Maximum	1	1	1	1	1
	Geo. Std. Dev.	0	0	0	0	0
	Median	1	1	1	1	1
	Coeff. of Var.	0	0	0	0	0
Hard., as $CaCO_3$, mg/L	Minimum	159	154	201	211	147
	Mean	161	156	204	213	150
	Maximum	162	158	205	217	152
	Std. Dev.	2	2	2	3	4
	Median	161	155	205	212	150
	Coeff. of Var.	1	1	1	2	2
NH_4^+–N, mg/L	Minimum	0.90	0.34	0.42	0.37	0.24
	Mean	0.94	0.35	0.43	0.39	0.24
	Maximum	0.98	0.37	0.44	0.41	0.24
	Std. Dev.	0.04	0.02	0.01	0.02	0.00
	Median	0.93	0.34	0.43	0.39	0.24
	Coeff. of Var.	4.31	4.95	2.33	5.13	0.00

Table 3 (Continued): SUMMARY STATISTICS OF THE 2005 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM–69 THROUGH QM–73

Parameter		Well Number				
		QM–69	QM–70	QM–71	QM–72	QM–73
pH	Minimum	7.3	7.6	7.5	7.5	7.7
	Mean	7.4	7.9	7.7	7.5	7.9
	Maximum	7.5	8.2	7.9	7.5	8.1
	Std. Dev.	0.1	0.3	0.2	0.0	0.3
	Median	7.5	8.0	7.6	7.5	7.9
	Coeff. of Var.	1.6	3.9	2.7	0.0	3.6
SO_4, mg/L	Minimum	43	52	69	1	1
	Mean	45	54	71	1	2
	Maximum	47	56	74	2	2
	Std. Dev.	3	2	3	0.36	1
	Median	45	54	71	1	2
	Coeff. of Var.	6	4	4	30	47
TDS, mg/L	Minimum	346	288	412	378	244
	Mean	360	315	455	430	292
	Maximum	382	342	478	512	340
	Std. Dev.	19	27	38	72	68
	Median	352	316	476	400	292
	Coeff. of Var.	5	9	8	17	23
TOC, mg/L	Minimum	1	1	1	0**	1
	Mean	2	1	1	1	2
	Maximum	2	2	2	2	3
	Std. Dev.	1	1	1	1	1
	Median	2	1	1	1	2
	Coeff. of Var.	35	43	43	100	71

*For purposes of statistical evaluation, fecal coliform values less than 1 were set equal to 1.

**A zero value indicates that the test result was below the detection limit (DL). The DL for total organic carbon is 0.3 mg/L.

Table 4: SUMMARY STATISTICS OF THE 2005 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM–74 THROUGH QM–78

Parameter		Well Number				
		QM–74	QM–75	QM–76	QM–77	QM–78
Cl, mg/L	Minimum	47	9	14	10	12
	Mean	49	13	19	11	14
	Maximum	50	16	28	11	17
	Std. Dev.	2	3	8	1	2
	Median	49	13	15	11	13
	Coeff. of Var.	3	19	41	5	13
Cond., µmhos/cm	Minimum	232	215	396	214	321
	Mean	313	264	429	224	386
	Maximum	404	294	478	236	434
	Std. Dev.	86	31	43	11	49
	Median	302	274	412	223	395
	Coeff. of Var.	28	12	10	5	13
FC,* cfu/100 mL	Minimum	1	1	1	1	1
	Geo. Mean	1	1	1	1	1
	Maximum	1	1	1	1	1
	Geo. Std. Dev.	0	0	0	0	0
	Median	1	1	1	1	1
	Coeff. of Var.	0	0	0	0	0
Hard., as $CaCO_3$, mg/L	Minimum	93	60	62	37	3
	Mean	93	62	66	40	10
	Maximum	94	64	70	42	12
	Std. Dev.	1	1	4	3	3
	Median	93	62	65	41	11
	Coeff. of Var.	1	2	6	7	34
NH_4^+–N, mg/L	Minimum	0.15	0.19	0.15	0.10	0.06
	Mean	0.20	0.22	0.17	0.12	0.09
	Maximum	0.22	0.25	0.18	0.14	0.11
	Std. Dev.	0.04	0.02	0.02	0.02	0.02
	Median	0.22	0.22	0.17	0.13	0.09
	Coeff. of Var.	20.55	9.79	9.17	16.88	20.21

Table 4 (Continued): SUMMARY STATISTICS OF THE 2005 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM–74 THROUGH QM–78

Parameter		Well Number				
		QM–74	QM–75	QM–76	QM–77	QM–78
pH	Minimum	7.0	7.1	7.0	7.0	7.5
	Mean	7.4	7.7	7.5	7.5	7.7
	Maximum	8.0	8.4	8.4	8.4	8.1
	Std. Dev.	0.6	0.5	0.8	0.8	0.2
	Median	7.1	7.6	7.2	7.2	7.6
	Coeff. of Var.	7.5	6.0	10.1	10.1	3.0
SO_4, mg/L	Minimum	1	10	91	1	53
	Mean	2	12	94	2	61
	Maximum	3	14	97	3	75
	Std. Dev.	1	1	3	1	8
	Median	2	12	94	3	59
	Coeff. of Var.	50	12	3	49	13
TDS, mg/L	Minimum	248	206	330	148	312
	Mean	264	236	379	186	346
	Maximum	288	258	444	224	370
	Std. Dev.	21	18	59	38	22
	Median	256	240	364	186	350
	Coeff. of Var.	8	8	15	20	6
TOC, mg/L	Minimum	1	1	1	0**	0**
	Mean	2	1	1	1	1
	Maximum	2	2	2	4	2
	Std. Dev.	1	1	1	2	1
	Median	2	1	1	0	1
	Coeff. of Var.	35	39	43	173	118

*For purposes of statistical evaluation, fecal coliform values less than 1 were set equal to 1.

**A zero value indicates that the test result was below the detection limit (DL). The DL for total organic carbon is 0.3 mg/L.

Table 5: SUMMARY STATISTICS OF THE 2005 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM–79 THROUGH QM–82

Parameter		Well Number			
		QM–79	QM–80	QM–81	QM–82
Cl, mg/L	Minimum	17	14	22	28
	Mean	19	15	25	29
	Maximum	20	18	31	30
	Std. Dev.	1	2	5	1
	Median	19	14	22	29
	Coeff. of Var.	6	11	21	2
Cond., µmhos/cm	Minimum	316	210	200	268
	Mean	372	233	240	301
	Maximum	409	255	300	370
	Std. Dev.	42	18	53	35
	Median	387	231	221	291
	Coeff. of Var.	11	8	22	12
FC,* cfu/100 mL	Minimum	1	1	1	1
	Geo. Mean	1	1	1	1
	Maximum	1	1	1	1
	Geo. Std. Dev.	0	0	0	0
	Median	1	1	1	1
	Coeff. of Var.	0	0	0	0
Hard., as $CaCO_3$, mg/L	Minimum	9	20	28	13
	Mean	10	21	29	13
	Maximum	10	23	29	14
	Std. Dev.	1	1	1	0
	Median	10	21	29	13
	Coeff. of Var.	6	6	2	3
NH_4^+–N, mg/L	Minimum	0.00**	0.00**	0.07	0.00**
	Mean	0.03	0.03	0.09	0.04
	Maximum	0.05	0.07	0.10	0.08
	Std. Dev.	0.02	0.03	0.02	0.03
	Median	0.03	0.02	0.10	0.04
	Coeff. of Var.	74.83	94.28	19.25	79.84

Table 5 (Continued): SUMMARY STATISTICS OF THE 2005 DATA FOR THE WATER QUALITY MONITORING WELLS IN THE MAINSTREAM TUNNEL SYSTEM: WELLS QM–79 THROUGH QM–82

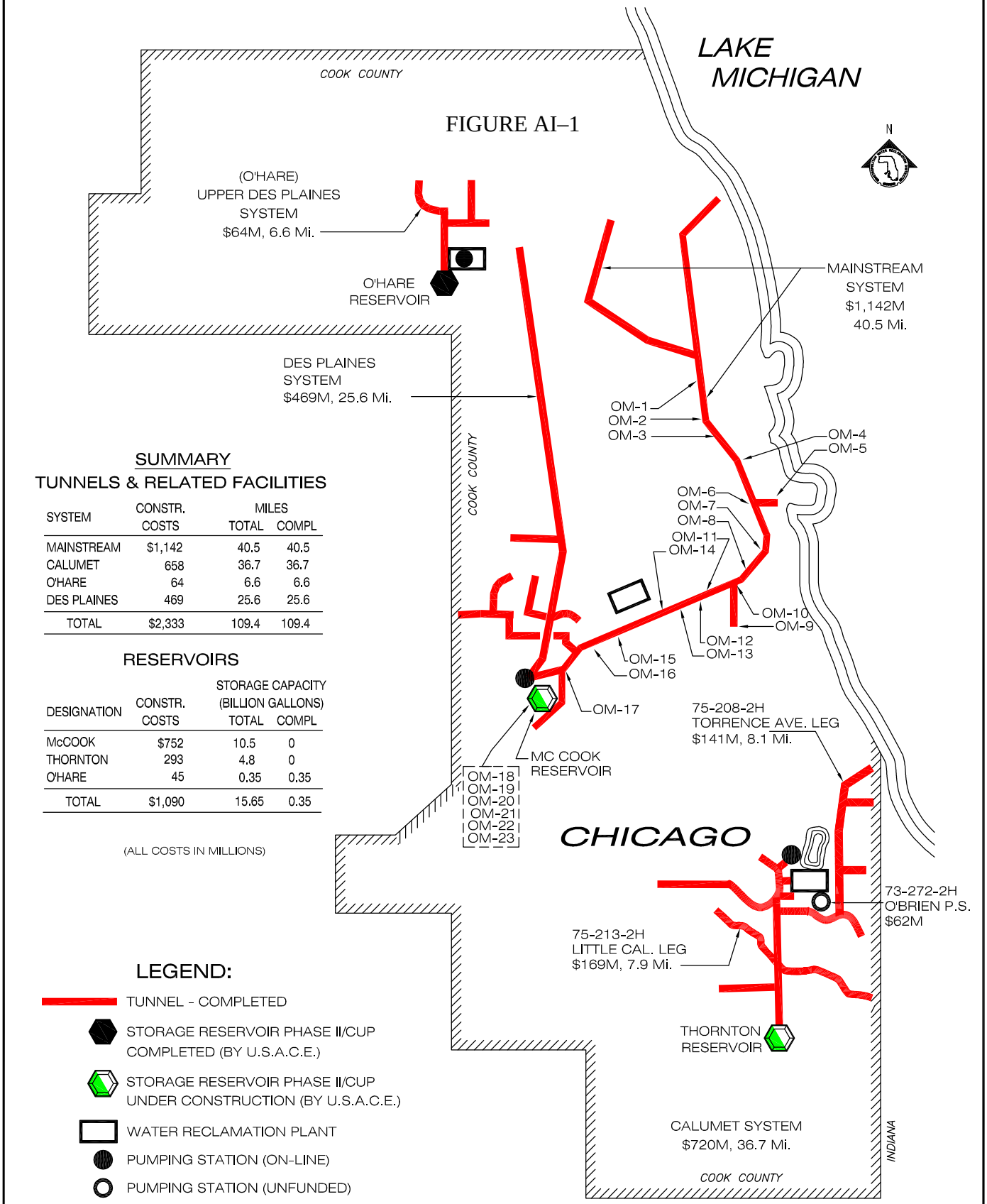
Parameter		Well Number			
		QM–79	QM–80	QM–81	QM–82
pH	Minimum	7.3	7.1	7.4	7.4
	Mean	7.6	7.5	7.5	7.6
	Maximum	8.1	7.9	7.7	7.9
	Std. Dev.	0.3	0.3	0.2	0.2
	Median	7.6	7.5	7.5	7.6
	Coeff. of Var.	3.8	3.7	2.0	3.1
SO_4, mg/L	Minimum	16	0**	11	0**
	Mean	20	3	13	10
	Maximum	26	6	15	14
	Std. Dev.	4	2	2	5
	Median	19	3	13	11
	Coeff. of Var.	19	73	15	54
TDS, mg/L	Minimum	304	196	212	268
	Mean	334	212	244	299
	Maximum	360	224	262	316
	Std. Dev.	23	10	28	16
	Median	337	213	258	302
	Coeff. of Var.	7	5	11	5
TOC, mg/L	Minimum	1	0**	0**	1
	Mean	2	1	1	2
	Maximum	2	1	1	3
	Std. Dev.	1	1	1	1
	Median	2	1	1	2
	Coeff. of Var.	37	77	87	49

*For purposes of statistical evaluation, fecal coliform values less than 1 were set equal to 1.

**A zero value indicates that the test result was below the detection limit (DL). The DLs for ammonia nitrogen, sulfate, and total organic carbon are 0.02 mg/L, 0.4 mg/L, and 0.3 mg/L, respectively.

APPENDIX AI

LOCATION MAP OF GROUNDWATER OBSERVATION WELLS OM–1 THROUGH OM–23 IN THE MAINSTREAM TUNNEL SYSTEM



MAINSTREAM TUNNEL SYSTEM LOCATION MAP OF GROUNDWATER OBSERVATION WELLS

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

I:\DMAC\MAINSTREAMObservationUpdated.dwg, 08/16/06 at 14.19

APPENDIX AII

2005 GROUNDWATER LEVEL ELEVATION DATA FOR OBSERVATION WELLS OM–1 THROUGH OM–23 IN THE MAINSTREAM TUNNEL SYSTEM

Table AII–1: 2005 GROUNDWATER LEVEL ELEVATION* DATA FOR OBSERVATION WELLS
OM–1 THROUGH OM–23 IN THE MAINSTREAM TUNNEL SYSTEM

Date	Observation Well											
	OM–1	OM–2	OM–3	OM–4	OM–5	OM–6	OM–7	OM–8	OM–9	OM–10	OM–11	OM–12
	feet											
2/4/05	-56.8	**	**	-103.6	-98.5	-44.4	-93.6	-72.2	-46.8	-30.0	-45.4	-10.7
4/15/05	-55.8	-51.7	-62.7	-104.6	-100.5	-45.4	-95.6	-73.2	-49.8	-30.0	-46.4	-11.7
6/3/05	-55.8	-49.7	-61.7	-102.6	-96.5	-45.4	-93.6	-71.2	-45.8	-29.5	-53.4	-10.7
8/12/05	-54.8	-49.7	-61.7	-102.1	-96.5	-43.9	-92.6	-70.7	-45.8	-29.0	-52.9	-10.7
9/9/05	-53.8	-48.2	-61.2	-100.6	-95.5	-42.9	-91.6	-68.7	-43.8	-28.0	-42.4	-10.7
11/17/05	-55.8	-49.7	-59.7	-99.6	-93.5	-41.4	-90.6	-70.2	-42.8	-28.0	-40.4	-12.7
Minimum	-56.8	-51.7	-62.7	-104.6	-100.5	-45.4	-95.6	-73.2	-49.8	-30.0	-53.4	-12.7
Mean	-55.5	-49.8	-61.4	-102.2	-96.8	-43.9	-92.9	-71.0	-45.8	-29.1	-46.8	-11.2
Maximum	-53.8	-48.2	-59.7	-99.6	-93.5	-41.4	-90.6	-68.7	-42.8	-28.0	-40.4	-10.7

Table AII–1 (Continued): 2005 GROUNDWATER LEVEL ELEVATION* DATA FOR OBSERVATION WELLS OM–1 THROUGH OM–23 IN THE MAINSTREAM TUNNEL SYSTEM

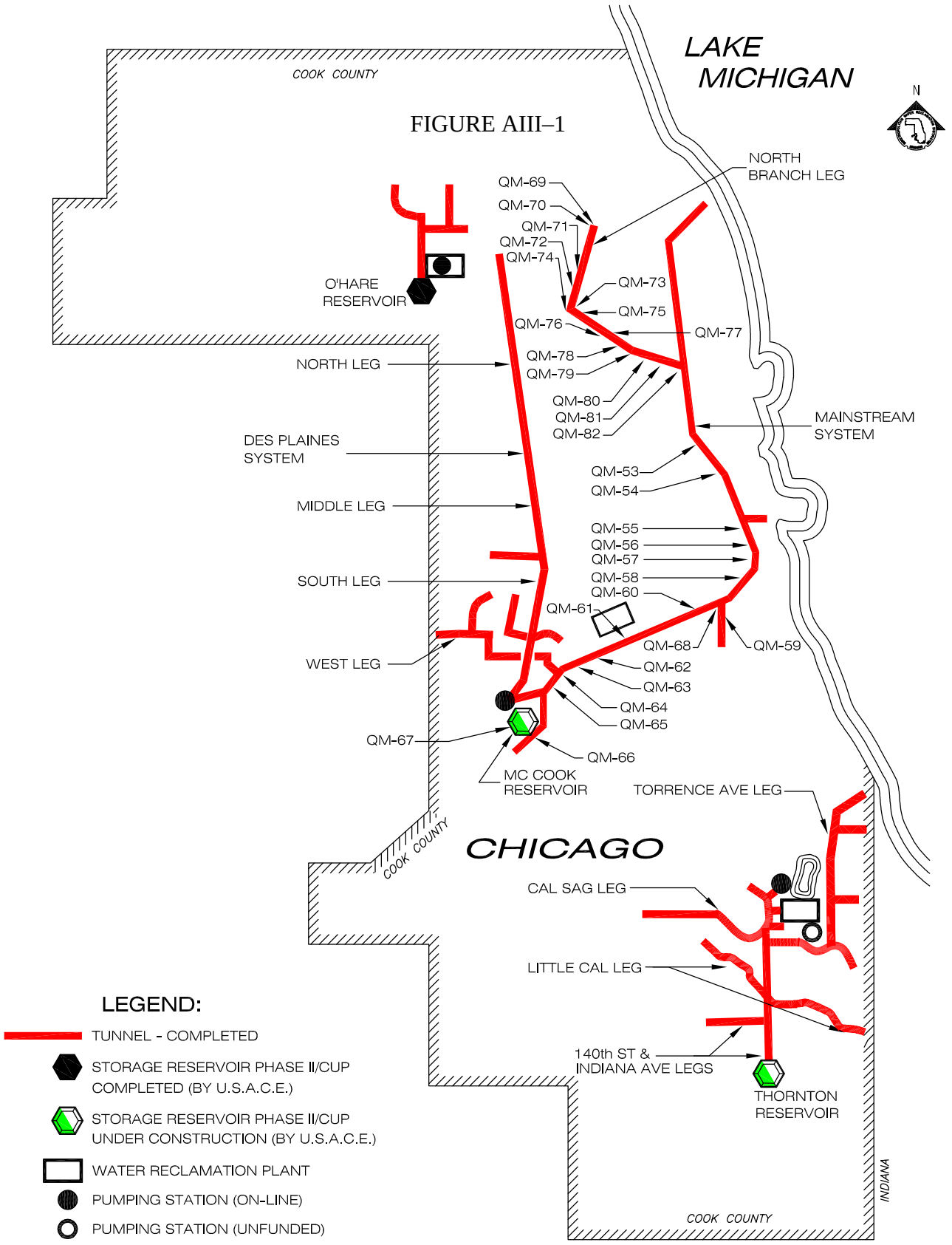
Date	Observation Well										
	OM–13	OM–14	OM–15	OM–16	OM–17	OM–18	OM–19	OM–20	OM–21	OM–22	OM–23
	feet										
2/4/05	41.4	-56.8	-178.3	-128.7	-143.0	-228.0	-92.0	-87.9	-93.9	-69.8	-228.7
4/15/05	40.4	-56.8	-180.3	-133.7	-141.0	-233.0	-94.5	-103.9	-90.9	-72.3	-230.7
6/3/05	42.4	-56.8	-180.3	-128.7	-137.0	-231.0	-90.5	-91.9	-68.9	-73.3	-209.7
8/12/05	42.4	-56.8	-178.3	-129.7	-137.0	-231.0	-90.5	-91.9	-72.9	-70.3	-203.7
9/9/05	41.4	-56.8	-178.3	-129.7	-139.0	-231.0	-137.5	-93.9	-70.9	-72.3	-205.7
11/17/05	41.4	-56.8	-178.3	-127.7	-138.0	-231.0	-93.5	***	-93.9	-71.3	-209.7
Minimum	40.4	-56.8	-180.3	-133.7	-143.0	-233.0	-137.5	-103.9	-93.9	-73.3	-230.7
Mean	41.6	-56.8	-179.0	-129.7	-139.2	-230.8	-99.8	-93.9	-81.9	-71.6	-214.7
Maximum	42.4	-56.8	-178.3	-127.7	-137.0	-228.0	-90.5	-87.9	-68.9	-69.8	-203.7

*Relative to Chicago City Datum.
**Snow blocked access to well.
***Road blocked, no access to well.

APPENDIX AIII

LOCATION MAP OF GROUNDWATER QUALITY
MONITORING WELLS QM–53 THROUGH QM–82
IN THE MAINSTREAM TUNNEL SYSTEM

FIGURE AIII–1



MAINSTREAM TUNNEL SYSTEM LOCATION MAP OF GROUNDWATER QUALITY MONITORING WELLS

METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO

I:\DMAC\MAINSTREAMMonitor Updated.dwg, 08/16/06 at 14.40

APPENDIX AIV

2005 GROUNDWATER QUALITY MONITORING DATA FOR WELLS QM–53 THROUGH QM–82 IN THE MAINSTREAM TUNNEL SYSTEM

Table AIV–1: 2005 pH, CONDUCTIVITY, TEMPERATURE, HARDNESS, AMMONIA NITROGEN, AND CHLORIDE DATA FOR WATER QUALITY MONITORING WELLS QM–53 THROUGH QM–82 IN THE MAINSTREAM TUNNEL SYSTEM

Well	Date of Sampling	pH[1]	Cond.[1] µmhos/cm	Temp. °C	Hard. as $CaCO_3$ mg/L	NH_4^+–N mg/L	Cl mg/L
QM–53	1/19/05	7.1	240	10	129	0.08	17
QM–53	4/13/05	7.4	257	12	134	0.08	15
QM–53	9/28/05	8.2	263	12	122	0.09	14
QM–56	1/19/05	7.8	372	12	132	0.47	40
QM–56	4/13/05	7.2	376	13	128	0.47	47
QM–56	9/28/05	8.0	396	14	121	0.47	39
QM–58	1/13/05	7.8	526	13	268	0.96	16
QM–58	6/30/05	7.3	542	14	265	0.96	22
QM–58	9/29/05	7.5	534	13	271	1.04	16
QM–61	6/15/05	7.6	531	13	108	0.25	47
QM–61	7/27/05	7.5	229	14	113	0.24	50
QM–61	9/28/05	8.0	439	15	108	0.27	45
QM–62	1/5/05	Well could not be sampled					
QM–62	5/25/05	Well could not be sampled					
QM–62	7/27/05	Well could not be sampled					
QM–62	9/8/05	Well could not be sampled					
QM–62	10/18/05	Well could not be sampled					
QM–62	11/8/05	Well could not be sampled					
QM–63	1/5/05	7.2	317	13	996	2.10	60
QM–63	4/13/05	7.6	1644	13	885	1.78	64
QM–63	5/25/05	7.4	1010	13	937	1.81	52
QM–63	7/27/05	7.3	750	14	845	1.60	51
QM–63	9/8/05	7.2	635	14	872	1.72	54
QM–63	11/8/05	7.6	1453	14	812	1.94	52
QM–64	1/5/05	7.4	458	13	212	1.95	53
QM–64	4/13/05	7.9	591	13	197	1.60	58
QM–64	5/25/05	7.5	418	14	201	1.82	52

Table AIV–1 (Continued): 2005 pH, CONDUCTIVITY, TEMPERATURE, HARDNESS, AMMONIA NITROGEN, AND CHLORIDE DATA FOR WATER QUALITY MONITORING WELLS QM–53 THROUGH QM–82 IN THE MAINSTREAM TUNNEL SYSTEM

Well	Date of Sampling	pH[1]	Cond.[1] µmhos/cm	Temp. °C	Hard. as $CaCO_3$ mg/L	NH_4^+–N mg/L	Cl mg/L
QM–64	7/27/05	7.2	364	14	200	1.80	52
QM–64	9/8/05	7.3	323	14	225	1.93	52
QM–64	11/8/05	7.5	619	14	206	1.98	56
QM–65	1/13/05	7.1	2100	13	609	9.01	456
QM–65	3/24/05	7.5	1110	13	570	6.36	362
QM–65	5/12/05	7.5	1054	13	562	6.74	382
QM–65	6/30/05	7.2	2017	14	559	7.17	387
QM–65	7/21/05	7.2	761	14	568	8.26	444
QM–65	9/29/05	7.6	2029	13	545	7.11	377
QM–67	1/13/05	7.0	1221	13	424	7.39	189
QM–67	3/24/05	7.2	995	13	409	7.69	252
QM–67	5/12/05	7.4	650	13	374	8.14	269
QM–67	7/21/05	7.4	734	16	387	8.45	242
QM–67	9/29/05	7.4	1239	14	362	9.54	204
QM–67	10/20/05	7.4	1171	14	347	9.14	171
QM–68	1/13/05	Well could not be sampled					
QM–68	5/12/05	7.4	310	13	207	1.31	379
QM–68	7/21/05	7.1	241	14	202	1.21	55
QM–69	1/27/05	7.3	292	10	162	0.98	36
QM–69	4/21/05	7.5	402	11	161	0.90	35
QM–69	6/22/05	7.5	302	12	159	0.93	35
QM–70	4/7/05	8.2	447	12	158	0.37	53
QM–70	6/2/05	7.6	304	12	154	0.34	47
QM–70	9/22/05	8.0	458	13	155	0.34	45
QM–71	4/7/05	7.6	467	11	201	0.44	130
QM–71	6/2/05	7.5	396	12	205	0.42	122
QM–71	9/22/05	7.9	640	12	205	0.43	118

Table AIV–1 (Continued): 2005 pH, CONDUCTIVITY, TEMPERATURE, HARDNESS, AMMONIA NITROGEN, AND CHLORIDE DATA FOR WATER QUALITY MONITORING WELLS QM–53 THROUGH QM–82 IN THE MAINSTREAM TUNNEL SYSTEM

Well	Date of Sampling	pH[1]	Cond.[1] µmhos/cm	Temp. °C	Hard. as $CaCO_3$ mg/L	NH_4^+–N mg/L	Cl mg/L
QM–72	1/27/05	7.5	356	10	217	0.39	136
QM–72	4/21/05	7.5	513	11	212	0.41	127
QM–72	6/22/05	7.5	377	12	211	0.37	132
QM–73	4/7/05			Well could not be sampled			
QM–73	6/2/05	7.7	266	12	152	0.24	45
QM–73	9/22/05	8.1	398	14	147	0.24	42
QM–74	4/14/05	7.0	302	11	93	0.15	47
QM–74	6/2/05	8.0	232	12	94	0.22	49
QM–74	8/4/05	7.1	404	12	93	0.22	50
QM–75	3/17/05	7.4	238	11	64	0.22	9
QM–75	4/28/05	7.8	215	11	63	0.25	12
QM–75	6/16/05	7.4	294	12	62	0.23	12
QM–75	8/18/05	8.4	267	13	61	0.20	16
QM–75	10/20/05	7.1	288	12	60	0.22	15
QM–75	12/8/05	7.9	280	10	62	0.19	14
QM–76	4/14/05	7.0	412	12	65	0.17	28
QM–76	8/4/05	7.2	396	13	62	0.18	15
QM–76	9/22/05	8.4	478	14	70	0.15	14
QM–77	4/14/05	7.0	214	12	42	0.13	11
QM–77	8/4/05	7.2	236	12	37	0.10	10
QM–77	9/22/05	8.4	223	13	41	0.14	11
QM–78	3/17/05	7.6	336	11	3	0.10	17
QM–78	4/28/05	7.5	321	11	11	0.11	13
QM–78	6/16/05	7.5	434	11	12	0.09	13
QM–78	8/18/05	7.8	376	12	10	0.06	12
QM–78	10/20/05	7.6	434	12	11	0.08	13
QM–78	12/8/05	8.1	413	10	10	0.08	13

Table AIV–1 (Continued): 2005 pH, CONDUCTIVITY, TEMPERATURE, HARDNESS, AMMONIA NITROGEN, AND CHLORIDE DATA FOR WATER QUALITY MONITORING WELLS QM–53 THROUGH QM–82 IN THE MAINSTREAM TUNNEL SYSTEM

Well	Date of Sampling	pH[1]	Cond.[1] µmhos/cm	Temp. °C	Hard. as $CaCO_3$ mg/L	NH_4^+–N mg/L	Cl mg/L
QM–79	3/17/05	7.3	324	11	10	0.05	17
QM–79	4/28/05	7.8	316	11	9	0.04	19
QM–79	6/16/05	7.4	409	12	10	0.03	19
QM–79	8/18/05	7.6	376	12	9	0.00[2]	18
QM–79	10/20/05	7.5	408	11	10	0.02	20
QM–79	12/8/05	8.1	397	10	9	0.01	19
QM–80	3/17/05	7.4	219	11	23	0.02	18
QM–80	4/28/05	7.3	210	12	21	0.07	14
QM–80	6/16/05	7.5	251	12	21	0.06	14
QM–80	8/18/05	7.6	223	13	20	0.00[2]	14
QM–80	10/20/05	7.1	255	12	20	0.02	14
QM–80	12/8/05	7.9	239	10	20	0.01	14
QM–81	1/27/05	7.5	200	11	28	0.10	22
QM–81	4/21/05	7.4	300	12	29	0.07	31
QM–81	6/22/05	7.7	221	13	29	0.10	22
QM–82	3/17/05	7.5	291	11	13	0.05	29
QM–82	4/28/05	7.9	287	12	13	0.06	29
QM–82	6/22/05	7.9	301	13	14	0.08	30
QM–82	8/25/05	7.4	268	13	13	0.03	28
QM–82	10/27/05	7.4	370	12	13	0.00[2]	29
QM–82	12/8/05	7.7	290	12	13	0.01	29

[1]Unfiltered samples, all others were filtered through 0.45 µm membrane.
[2]A zero value indicates that the test result was below the detection limit (DL). The DL for ammonia nitrogen is 0.02 mg/L.

Table AIV–2: 2005 SULFATE, TOTAL ORGANIC CARBON, TOTAL DISSOLVED SOLIDS, FECAL COLIFORM, WATER ELEVATION, AND RECHARGE DATA FOR WATER QUALITY MONITORING WELLS QM–53 THROUGH QM–82 IN THE MAINSTREAM TUNNEL SYSTEM

Well	Date of Sampling	SO_4 mg/L	TOC mg/L	TDS mg/L	FC[1] cfu/100 mL	Water Elevation[2] Feet	Recharge[3] Hours
QM–53	1/19/05	33	1	246	<1	-22	<4
QM–53	4/13/05	34	1	186	<1	-38	<4
QM–53	9/28/05	34	1	208	<1	-39	<4
QM–56	1/19/05	15	2	277	<1	-76	<4
QM–56	4/13/05	12	2	304	<1	-76	<4
QM–56	9/28/05	7	1	296	<1	-75	<4
QM–58	1/13/05	159	2	426	<1	-100	<4
QM–58	6/30/05	171	1	480	<1	-100	<4
QM–58	9/29/05	169	1	474	<1	-107	<4
QM–61	6/15/05	26	1	316	<1	-180	<4
QM–61	7/27/05	8	1	296	<1	-175	<4
QM–61	9/28/05	6	1	296	<1	-179	<4
QM–62	1/5/05			Well could not be sampled			
QM–62	5/25/05			Well could not be sampled			
QM–62	7/27/05			Well could not be sampled			
QM–62	9/8/05			Well could not be sampled			
QM–62	10/18/05			Well could not be sampled			
QM–62	11/8/05			Well could not be sampled			
QM–63	1/5/05	900	4	1878	<1	-167	<4
QM–63	4/13/05	796	3	1618	<1	-191	<4
QM–63	5/25/05	1008	4	1838	<1	-189	<4
QM–63	7/27/05	912	2	1578	<1	-181	<4
QM–63	9/8/05	913	2	1744	<1	-183	<4
QM–63	11/8/05	934	2	1642	<1	-191	<4
QM–64	1/5/05	37	3	458	<1	-184	<4
QM–64	4/13/05	34	2	494	<1	-168	<4
QM–64	5/25/05	41	2	594	<1	-165	<4

Table AIV–2 (Continued): 2005 SULFATE, TOTAL ORGANIC CARBON, TOTAL DISSOLVED SOLIDS, FECAL COLIFORM, WATER ELEVATION, AND RECHARGE DATA FOR WATER QUALITY MONITORING WELLS QM–53 THROUGH QM–82 IN THE MAINSTREAM TUNNEL SYSTEM

Well	Date of Sampling	SO_4 mg/L	TOC mg/L	TDS mg/L	FC[1] cfu/100 mL	Water Elevation[2] Feet	Recharge[3] Hours
QM–64	7/27/05	41	1	540	<1	-163	<4
QM–64	9/8/05	44	1	588	<1	-164	<4
QM–64	11/8/05	40	1	530	<1	-168	<4
QM–65	1/13/05	182	12	1494	3	-190	<48
QM–65	3/24/05	218	8	1374	<1	-199	<48
QM–65	5/12/05	218	9	1440	<1	-195	<48
QM–65	6/30/05	216	7	1462	<1	-190	<48
QM–65	7/21/05	205	6	1504	<1	-183	<48
QM–65	9/29/05	206	6	1360	<1	-183	<48
QM–67	1/13/05	105	5	996	260	-167	<48
QM–67	3/24/05	57	5	1000	3500	-168	<48
QM–67	5/12/05	33	6	994	190	-174	<48
QM–67	7/21/05	38	3	920	54	-159	<48
QM–67	9/29/05	31	4	902	47	-157	<48
QM–67	10/20/05	31	4	840	1200	-163	<48
QM–68	1/13/05			Well could not be sampled			
QM–68	5/12/05	34	1	380	<1	-136	<48
QM–68	7/21/05	38	1	328	<1	-130	<48
QM–69	1/27/05	47	2	346	<1	-38	<48
QM–69	4/21/05	52	2	382	<1	-39	<48
QM–69	6/22/05	43	1	352	<1	-37	<48
QM–70	4/7/05	54	1	342	<1	-75	<48
QM–70	6/2/05	56	2	316	<1	-70	<48
QM–70	9/22/05	52	1	288	<1	-68	<48
QM–71	4/7/05	69	2	478	<1	-66	<48
QM–71	6/2/05	74	1	476	<1	-60	<48
QM–71	9/22/05	71	1	412	<1	-56	<48

Table AIV–2 (Continued): 2005 SULFATE, TOTAL ORGANIC CARBON, TOTAL DISSOLVED SOLIDS, FECAL COLIFORM, WATER ELEVATION, AND RECHARGE DATA FOR WATER QUALITY MONITORING WELLS QM–53 THROUGH QM–82 IN THE MAINSTREAM TUNNEL SYSTEM

Well	Date of Sampling	SO_4 mg/L	TOC mg/L	TDS mg/L	FC[1] cfu/100 mL	Water Elevation[2] Feet	Recharge[3] Hours
QM–72	1/27/05	2	2	400	<1	-79	<48
QM–72	4/21/05	1	1	378	<1	-72	<48
QM–72	6/22/05	1	0[4]	512	<1	-68	<48
QM–73	4/7/05			Well could not be sampled			<48
QM–73	6/2/05	2	3	340	<1	-111	<48
QM–73	9/22/05	1	1	244	<1	-110	<48
QM–74	4/14/05	2	2	288	<1	-24	<48
QM–74	6/2/05	1	2	256	<1	-20	<48
QM–74	8/4/05	3	1	248	<1	-6	<48
QM–75	3/17/05	12	2	206	1	-61	<48
QM–75	4/28/05	14	1	244	<1	-61	<48
QM–75	6/16/05	12	2	246	<1	-63	<48
QM–75	8/18/05	13	1	258	<1	-59	<48
QM–75	10/20/05	10	1	236	<1	-56	<48
QM–75	12/8/05	11	1	228	<1	-59	<48
QM–76	4/14/05	97	2	444	<1	-187	<48
QM–76	8/4/05	94	1	364	<1	-108	<48
QM–76	9/22/05	91	1	330	<1	-123	<48
QM–77	4/14/05	3	4	224	<1	-174	<48
QM–77	8/4/05	3	0[4]	186	<1	-166	<48
QM–77	9/22/05	1	0[4]	148	<1	-167	<48
QM–78	3/17/05	62	2	312	<1	-66	<48
QM–78	4/28/05	75	1	342	<1	-158	<48
QM–78	6/16/05	60	2	370	<1	-67	<48
QM–78	8/18/05	57	0[4]	332	<1	-158	<48
QM–78	10/20/05	53	0[4]	358	<1	-63	<48
QM–78	12/8/05	56	0[4]	362	<1	-161	<48

Table AIV–2 (Continued): 2005 SULFATE, TOTAL ORGANIC CARBON, TOTAL DISSOLVED SOLIDS, FECAL COLIFORM, WATER ELEVATION, AND RECHARGE DATA FOR WATER QUALITY MONITORING WELLS QM–53 THROUGH QM–82 IN THE MAINSTREAM TUNNEL SYSTEM

Well	Date of Sampling	SO_4 mg/L	TOC mg/L	TDS mg/L	FC[1] cfu/100 mL	Water Elevation[2] Feet	Recharge[3] Hours
QM–79	3/17/05	18	2	336	<1	-95	<48
QM–79	4/28/05	26	2	360	<1	-145	<48
QM–79	6/16/05	19	2	312	<1	-94	<48
QM–79	8/18/05	21	1	338	<1	-140	<48
QM–79	10/20/05	16	1	356	<1	-93	<48
QM–79	12/8/05	17	1	304	<1	-140	<48
QM–80	3/17/05	5	1	196	<1	-129	<48
QM–80	4/28/05	0[4]	1	220	<1	-128	<48
QM–80	6/16/05	3	1	224	<1	-126	<48
QM–80	8/18/05	2	0[4]	214	<1	-136	<48
QM–80	10/20/05	2	1	208	<1	-128	<48
QM–80	12/8/05	6	0[4]	212	<1	-134	<48
QM–81	1/27/05	13	1	212	<1	-133	<48
QM–81	4/21/05	15	1	258	<1	-132	<48
QM–81	6/22/05	11	0[4]	262	<1	-130	<48
QM–82	3/17/05	9	2	268	<1	-159	<48
QM–82	4/28/05	14	3	302	<1	-187	<48
QM–82	6/22/05	9	1	308	<1	-157	<48
QM–82	8/25/05	13	1	302	<1	-160	<48
QM–82	10/27/05	0[4]	2	300	<1	-159	<48
QM–82	12/8/05	12	1	316	<1	-160	<48

[1]Unfiltered samples, all others were filtered through 0.45 μm membrane.
[2]Water level elevations are relative to Chicago City Datum.
[3]Refers to elapsed time after initial drawdown before the well recovered sufficiently for sampling.
[4]A zero value indicates that the test result was below the detection limit (DL). The DLs for sulfate and total organic carbon are 0.4 mg/L and 0.3 mg/L, respectively.